PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements relating to Non-Woven Textile Webs

We, JOHNSON & JOHNSON, a Corporation organised under the laws of the State of New Jersey, United States of America, of 501 George Street, New Brunswick, New Jersey, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to nonwoven unitary webs; more particularly to fibrous webs of continuous synthetic textile filaments and to methods of making the same. These textile filaments are known man-made materials, being either artificial or synthetic in nature as hereinafter indicated, as distinct from natural fibers such as cotton, wool, etc. For convenience herein they will hereinafter be referred to as "synthetic filaments" and/or "synthetic textile filaments".

As used herein the term "web" means a thin, flimsy, fibrous sheet of indefinite length as distinguished from ribbons or batts which have considerable thickness.

Heretofore, fibrous webs have been made from staple length fibers and/or short paper-making fibers, i.e., fibers less than about two inches in length. Such webs are made by a card engine or by paper-making or air-laying machines. These machines produce a thin sheet or web of overlapping, intersecting, randomly arranged fibers. The web is held together by the frictional entanglement of the fibers and is quite weak.

Nonwoven fabrics are produced from these prior art webs by plying a number of the webs together and applying an adhesive to the laminate to bond the same into a unitary structure.

The present invention contemplates a nonwoven unitary web of individual synthetic textile filaments. Each filament in the web has an irregular sinuosity throughout its length, thus presenting looped fiber portions which overlap and frictionally engage looped fiber portions of adjacent filaments of the web. Each filament in a unit section of the web has a length in its irregular sinuous form equal to the length of the unit web section as measured in the direction of filament lie, and each filament of the unit section has a length in its stretched or straightened condition substantially equal to the corresponding length of its associated filaments of the unit section in their straightened condition.

As a filament in a unit section, whether the filament is in its sinuous form or in its straightened condition, is of substantially the same length as its adjacent filaments in the same condition the resulting web is of substantially uniform construction throughout its entire area. The unitary web will have a substantially uniform density and uniform "covering" properties, i.e., free of holes or thick areas.

Substantially all of the filaments lie in the same general direction and the nonwoven unitary webs of the invention have considerable strength in the direction in which the filaments lie. Strong nonwoven fabrics may be produced by plying a number of these webs together, usually at angles to each other, and adding a small amount of adhesive to hold the plies together.

The fabrics produced from the webs of the invention have strength and softness characteristics which are not directly dependent on each other.

For example, the starting web for conventional nonwoven fabrics is very soft and weak. Adhesive is applied to the web to hold the staple length fibers together. Though the web develops strength by the

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addition of adhesive it also becomes harsher. Generally the more adhesive that is applied the stronger the resultant fabric and also the harsher the resultant fabric.

In contrast, if the webs of the invention are used to produce a nonwoven fabric, adhesive is applied to hold plies of webs together rather than to hold fibers together. Strong fabrics may be produced with relatively small amounts of adhesive which allows the final fabric to retain the excellent softness of the webs of the invention.

The strength of the webs of the invention is more dependent on the strength of the filaments used and less dependent on the frictional entanglement of filaments and the amount of adhesive applied. This is in contrast to a web of staple length fibers whose strength is less dependent on the strength of the fiber used and more dependent on the frictional entanglement of fibers and the amount of adhesive applied.

The softness characteristics of fabrics made from the webs of the invention are different than the softness characteristics of prior art nonwoven fabrics since the softness of the webs of the invention is a result of filament surface whereas in the prior art fabrics the softness is the result of loose fiber ends, i.e., fiber ends which have not been tied down by adhesive. The large surface area, free of adhesive and fiber ends, gives the webs of the invention a cool, smooth, silk-like softness and makes the fabrics produced from these webs particularly suitable for use as surgical dessings, absorbent dressings, sanitary napkin covers, diapers, etc.

The present invention contemplates methods for producing the nonwoven unitary webs of the invention from a tow of continuous synthetic filaments. Thus, for example, these webs may be made by presenting a tow of continuous synthetic filaments to a liquid flowing through a chamber; any liquid which does not adversely affect the filament may be used; suitable examples are water, alcohol, etc. The tow and liquid move in the same direction but the velocity of the tow is slower than the velocity of the liquid. The flow of the liquid is controlled to present diverging hydraulic forces in the body of the liquid which open the tow and spread it into a thin web of continuous filaments, which is then picked up from the liquid at a slower speed than the speed of the tow while in said liquid. The thin web is presented to a condensing surface and the filaments therein become condensed or compacted lengthwise, in effect "shortened lengthwise" so that each filament assumes an irregular sinuous path. By effecting a substantially uniform lengthwise condensation of the filaments, the resulting web is of substantially uniform construction throughout its entire area. The resulting web is substantially free of voids, thin areas and thick areas and the filaments relatively uniformly cover the entire surface. The sinuous filaments present looped portions which overlap and entangle looped portions of adjacent filaments.

In spreading the tow of continuous filaments into a web the filaments must be maintained under tension until the desired width of the web is attained. The tension may be obtained by the application of hydraulic forces to the tow as it is spread into a web. The hydraulic forces must be strong enough to part the slightly tangled filaments yet gentle enough so that they do not form either open places or conglomerations of filaments in the web. After the tow is spread into a web, the web is placed on a conveyor, moving at a relatively slower speed than the web, and the tension the filaments are under is thus released. This allows the filaments to take the configuration imparted to them by the differential in speed between the filaments and the conveyor.

When the tension is released the filaments fall in sinuous paths and form looped fiber portions which overlap and entangle looped fiber portions of adjacent filaments to form a nonwoven unitary web. The length of each individual filament in its irregular sinuous path is equal to the length of the web formed.

The invention will be further described in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a plan view of a nonwoven unitary web of the present invention,

FIG. 2 is an enlarged cross-sectional view taken along line 2-2 of FIG. 1,

FIG. 3 is a plan view of a fabric made from a unitary web of this invention,

FIG. 4 is an enlarged cross-sectional view taken along line 4-4 of FIG. 3,

FIG. 5 is a plan view of another fabric made from a nonwoven unitary web of this invention,

FIG. 6 is a plan view of an apparatus for carrying out certain steps in the method of this invention,

FIG. 7 is a side elevation view of the apparatus shown in FIG. 6,

FIG. 8 is a photomicrograph of a typical nonwoven web of the present invention at an original enlargement of approximately 20 to 1,

FIG. 9 is a photomicrograph of another nonwoven web of the present invention at an original enlargement of approximately 20 to 1, and

FIG. 10 is a photomicrograph of still another nonwoven web of the present invention at an original enlargement of approximately 20 to 1.

Referring to the drawings, in FIG. 1 there

is shown a nonwoven unitary web 21 of the invention. The web comprises individual filaments 22 each of which lies in a sinuous path running in the direction of the length of the web. Looped or kinky portions of filaments overlap and entangle looped or kinky portions of adjacent filaments. Each individual filament in the web is at least as long as the length of the web formed. The web is very thin with the filaments 22 relatively uniformly distributed throughout the width of the web, as indicated in FIG. 2.

In FIG. 3 there is shown a fabric 23 made from two superposed webs of the invention. The first web 24 contains individual filaments 25 whose sinuous paths lie in the direction of the length of the fabric produced. The length of each individual filament in its sinuous path is equal to the length of the web formed. A second web 26 containing individual filaments 27 lying in irregular sinuous paths is plied with the above-mentioned web so that the filaments in the second web run the width of the fabric. The length of the filaments in this web, in their sinuous paths, is approximately equal to the width of the fabric. The two webs are held together by a binder 28 applied in any desired manner, suitably in a pattern of parallel lines running at an angle of about 45° to the length of the fabric.

In FIG. 5 there is shown another fabric 29 made from a nonwoven unitary web 30 of the invention and a superposed fibrous web 32 of randomly arranged staple length fibers. In web 30 the continuous filaments 31 lie in sinuous paths running in the direction of the length of the fabric. Each filament 31 is at least as long as the length of the fabric and presents looped portions which overlap and entangle looped portions of adjacent filaments. The two webs are held together by an adhesive binder 33 applied in any desired manner, suitably in the form of a pattern of dots as shown. The strength of this fabric is much greater in the long direction than in the cross-direction and the softness or "feel" is different on each side. The continuous filament side has a silk-like softness and the side containing the randomly arranged staple length fibers has a nap-like or flannel-like softness.

The webs of the invention may be produced from any of the known synthetic filaments, including artificial filaments. Suitable examples are viscose rayon, cuprammonium rayon, ethylcellulose, cellulose acetate, and nylon; polyesters, i.e., "Dacron"; acrylics, i.e., "Orlon", "Acrilan" and "Dynel"; polyolefins, i.e., polyethylene, polypropylene; polyvinylidene chloride, i.e., "Saran"; polyvinyl chloride, polyurethanes, etc. These synthetic filaments may be used alone or in combination with one another. (The words "Dacron", "Orlon", "Acrilan", "Dynel" and "Saran" are registered Trade Marks).

The weight of the webs of the invention range from about 25 grains per square yard to 200 grains per square yard and preferably from about 35 grains per square yard to 100 grains per square yard.

The denier of the filaments used to produce the webs of the invention is in the range of from 1 denier to about 10 denier. It is preferred that the filaments have a denier in the range of from $1\frac{1}{2}$ to 6. For example, viscose rayon filaments from $1\frac{1}{2}$ to 3 denier have produced excellent results in the production of the fabrics of the invention.

Filaments having a denier above the indicated broad range are stiff and rigid and will not lie in irregular sinuous paths uniformly throughout the web. The fabrics produced from webs of such high denier filaments are not drapable textile fabrics having a silk-like softness as contemplated herein, but are rigid and harsh and unsuitable for use in surgical dressings, sanitary napkins and the like.

In the formation of the webs of the present invention, as shown in FIGS. 6 and 7, a bundle 40 of continuous filaments 41 having no definite twist (called a tow) is continuously fed by a pair of nip rolls 42 into the opening 43 of a chamber 44 containing a flowing liquid. The tow and liquid move in the same direction, but the velocity of the tow is less than that of the liquid; the drag of the liquid on the lower moving tow pulls the tow through the chamber.

The cross-sectional shape of the chamber is rectangular at the end at which the tow enters. The sides of the chamber diverge from the entry end to the discharge end while the top and the bottom of the chamber converge from the entry end to the discharge end, so that the rectangular shape is widened and flattened to form a slot 45 at the discharge end of the chamber. The divergence and convergence of the walls are such that the area of the chamber either remains substantially constant along the length of the chamber, or decreases slightly in the downstream direction.

The liquid enters the chamber at an opening at the same end of the chamber at which the tow enters, suitably as at 46. On entering the liquid impinges on a baffle 47 so as to prevent any major disruption of the tow. The liquid continually flows through the chamber at a velocity greater than the velocity at which the tow passes through the chamber and thus maintains the tow under tension as it passes through the chamber. As the tow enters the chamber, the flowing liquid opens the tow and sepa-

rates the continuous filaments into a flat band. The flat band is continually separated and widened as it passes through the chamber to the discharge end. The tow is separated by the shear stress exerted by the liquid on the tow. This stress is in the same direction as the liquid velocity and where the walls and flow are divergent the stress has a shear force component perpendicular to the centerline of the chamber. This perpendicular force component spreads the tow as it passes through the chamber. At the discharge end of the chamber the flat band is in the form of a web 48 of continuous filaments and this web is placed on a continuous wire screen 49.

The upper reach of the wire screen passes from roller 50 closest to the chamber to roller 51 spaced away from the chamber and the lower reach from the roller 51 to roller 50. As the spread tow contacts the screen, which is moving slower than the tow, the tension is released. The individual filaments fall in irregular sinuous paths on the screen, forming looped portions in the individual filaments, which overlap and entangle looped portions of adjacent filaments.

The screen with the spread tow (web) thereon passes over a suction box 52 to remove liquid therefrom. The web and screen then pass to a hot air drier 53 where the web of continuous filaments is dried. The irregular sinuous paths of the continuous filaments causes portions of filaments to overlap and frictionally engage portions of adjacent filaments to form a unitary web. The dried unitary web 54 may then be laminated with carded, air-laid or other nonwoven fiber webs or with other spread tow webs to produce a composite fabric.

The liquid used is relatively unimportant in the spreading of tow provided the liquid has no adverse effects on the filaments. Economics, safety, ease of handling, etc., make the use of water one of the better liquids for the spreading of tow.

The more important variables in the spreading of tow of fine denier filaments according to the method of the invention are: the type of liquid flow, the condition of the layer of liquid at the diverging sides of the chamber and the relative speed of the tow in the liquid.

The type of liquid flow in chamber 44 may be either laminar or turbulent. This flow is controlled primarily by the velocity of the liquid in the chamber, and by the shape of the chamber.

The liquid layer at the sides of the chamber has flow characteristics which do not adversely affect the desired spreading of the tow. There is a minimum of turbulence, i.e., the formation of vortices or "eddy" currents at the side walls are kept to a minimum. The condition of the liquid layer at the side walls may be controlled by maintaining the angle of divergence of these walls at less than 10° or by placing release ports or slits along the wall in order to equalize liquid pressure throughout the chamber.

The liquid velocity in the chamber is greater than the velocity of the tow as it passes through the chamber to maintain the tow under tension and allow the action of the liquid to act on the tow and spread it into web form. Satisfactory results have been obtained with water velocities in the range of from about 50 feet per minute to 500 feet per minute and somewhat higher. As the liquid velocity is raised above the indicated range the problems of preventing velocity fluctuations and the formation of voctices at the walls of the chamber increase. This can be minimized by decreasing the cross-sectional area of the chamber, and thereby increasing the velocity, in the downstream direction to give a favorable pressure gradient, which enhances the stability of the flow and retards flow separation.

Velocity fluctuations may also be reduced by making the distance between the converging walls of the chamber as small as practical. The width of the chamber at the downstream end should be nearly the same as the desired width of the web. The chamber depth at this location should be quite small, on the order of one-sixteenth inch or less, to give a uniform distribution of filaments across the web.

Once the tow is spread into web form it is presented to hte slower moving condensing surface of the wire screen. The differential in speed between the tow and the wire may be varied over wide ranges to impart various irregular sinuous paths to the filaments. This speed differential also governs the amplitude of the sinuous path of individual filaments in the web. Differentials in the speed of the tow and the speed of the wire in the range of from 1.05 to 1 to 2 to 1 and even higher have given satisfactory results.

By the method of the invention tows ranging in diameter from 1/32 of an inch up to about 1 inch or more and containing from 5,000 to 60,000 filaments or more may be spread to thin flimsy webs having weights ranging from about 25 grains per square yard up to about 200 grains per square yard or more.

In FIGS. 8, 9 and 10 there are shown portions of typical nonwoven unitary webs produced by spreading tows of continuous filaments. The webs contain individual filaments which have an irregular sinuosity and present looped fiber portions which overlap and frictionally engage looped fiber portions of adjacent filaments. The filaments

extend from one end of the web to the opposite end and do not present fiber ends on the surface of the fabric but, rather, present extended filament surfaces which produce a cool, silk-like softness in the web.

The degree of fiber looping of adjacent filaments varies in FIGS. 8, 9 and 10 and is dependent on the degree of condensing present when the web of spread filaments is removed from the spreading operation, i.e., the differential in speed between the spread tow and the screen which picks up the spread tow from the spreading liquid. The web of FIG. 9 indicates the effect of the lowest speed differential and that of FIG. 8 the highest speed differential of the three figures.

The invention will be further illustrated in greater detail by the following specific examples. The percentages indicated are by weight unless specifically stated otherwise.

EXAMPLE 1

A viscose rayon tow approximately $\frac{3}{32}$ of an inch in diameter, 6,000 denier, and containing 2,934 individual continuous filaments of about 2 denier per filament is fed by a pair of nip rolls into a spreading chamber at the rate of approximately 40.5 feet per minute. The spreading chamber is 28$\frac{1}{2}$ inches long. The cross-sectional dimensions at the entry end are $\frac{3}{4}$ inch wide by $\frac{1}{2}$ inch high and at the discharge end are 6 inches wide by $\frac{1}{16}$ inch high. The cross-sectional area is substantially constant over the entire length of the chamber. A flow of water is maintained in the chamber through a tube fastened to the bottom of the chamber near the entry end as indicated in FIG. 7. A baffle is used to deflect the water forward into the chamber as it enters through this tube, again as indicated. The water velocity through the chamber is approximately 395 feet per minute.

The tow passes through the entry hole into the chamber and the flow of water pulls the tow through the chamber. Divergent currents of water cause the filaments to spread in a fan-shaped pattern. The tow is removed from the discharge end as a substantially uniform sheet of continuous filaments 6 inches wide. These filaments are discharged onto a wire screen passing over a suction box. The screen is moving at 38$\frac{1}{2}$ feet per minute. The suction box removes the water from the continuous filament sheet and the reduced speed of the wire causes the individual filaments to lie in irregular, sinuous paths and form looped portions which overlap and entangle looped portions of adjacent filaments.

The sheet on the screen is passed under a spray of approximately 1% polyvinyl alcohol solution and over a second suction box to remove more water from the sheet. The sheet is then passed under a hot air dryer to remove the remainder of the water and the dry sheet rolled on a core. The non woven unitary base web produced is approximately 6 inches wide and weighs 56 grains per square yard.

EXAMPLE 2

A base web is made as outlined in Example 1 from 2-denier viscose rayon continuous filaments. The web is approximately 6 inches wide and weighs 80 grains per square yard. This web is used to form a fabric by angle laying two pieces of the web between two other pieces of the web to form four-ply laminate. The filaments of the outer plies run the length of the laminate while the filaments in one of the inner plies lie at 60° measured clockwise from this length and the filaments in the other inner ply lie at 60° measured counterclockwise from this length.

The four-ply laminate is held together by a viscose binder applied in a pattern of 6 lines per inch with the lines running at an angle of 45° to the length of the fabric. The final weight of the fabric is 340 grains per square yard with 20 grains per square yard of this being binder and 320 grains per square yard being continuous filaments.

The strength of the fabric is determined by taking a 1-inch by 6-inch sample and placing it between the jaws of a conventional Constant-Rate-of-Elongation tester, for example, the one sold by the Insco Corporation. The jaws of the machine are 4 inches apart and after the sample is clamped between the jaws, the jaws are separated at a rate of 4 inches per minute until the fabric breaks. When the sample breaks, the tenacity of the fabric is recorded. Five samples are tested with the 6-inch length running in the machine direction of the fabric, i.e., the length of the fabric, and five samples are tested with the 6-inch length running in the cross direction of the fabric, i.e., the width of the fabric. The final strengths in the machine- and cross-directions are then determined by taking an average of the five samples.

The machine direction tenacity of the fabric of this sample is determined to be 2.15 pounds per inch per 100 grains per square yard and the cross-direction tenacity is determined to be 1.66 pounds per inch per 100 grains per square yard.

The softness of this fabric is determined by two different techniques, as follows:

The flexural rigidity (resistance) of the fabric is determined by cutting an 8$\frac{1}{2}$-inch square sample from the fabric and testing the same on a Thwing-Albert Handle-O-Meter. In this instrument a metal bar bends the fabric and the resistance to flex is deter-

mined in milliamperes which is converted to a "softness" figure in accordance with known procedures. As this figure increases, the softness or flexibility increases. The average flexibility of this fabric as determined by this machine is about 86.

A combination of the surface softness and flexibility of the fabric is also determined by cutting a 6-inch by 7-inch sample randomly from the fabric. This sample is pushed down into a trumpet, the large end of which is $2\frac{5}{8}$ inches in diameter and the small end of which is $\frac{7}{8}$ inch in diameter. The sides of the trumpet curve inwardly toward the center of the trumpet and have a radius of curvature of $\frac{7}{8}$ inch. The small end of the trumpet is intengral with a cylinder $\frac{7}{8}$ inch in diameter and $3\frac{5}{8}$ inches in length. The sample is pushed down into the trumpet and through the cylinder by a vertical probe. At the bottom of this probe is a spherical ball $\frac{5}{8}$ inch in diameter. The top of the probe is attached to a cantilever weigh-bar system. The motion of this weigh-bar is converted electronically to an electric signal which is calibrated in terms of grams of force exerted by the sample on the probe. Hence, the final reading in grams of force will decrease as the surface softness and flexibility increase. The surface softness and flexibility of this sample, determined as described, is 10 grams of force.

EXAMPLE 3

A second fabric is made by taking a continuous filament web as outlined in Example 1 and angle-laying this between plies of normal carded web. The outer plies or corded webs each weigh approximately 85 grains per square yard and are made from viscose rayon fibers $1\frac{1}{2}$-denier and $1\frac{9}{16}$ inches in length. The two inner plies are made from the continuous filament web outlined in Example 1. One of the inner plies lies at 60° measured clockwise from the length of the final laminate, while the other inner ply lies at 60° measured counterclockwise from the length of the final laminate.

The 4-ply laminate is held together by a viscose binder applied in a pattern of 12 diagonal lines to the inch with the lines running at 20° to the cross-direction of the fabric. The final fabric weighs 302 grains per square yard with 20 grains per square yard of this being binder, 112 grains per square yard being continuous filament web and 170 grains per square yard being normal carded web.

The strength of the fabric is determined by the Constant-Rate-of-Elongation tester in the same manner as outlined in Example 2. The machine direction tenacity of this fabric is 1.21 pounds per inch per 100 grains per square yard and the cross-direction tenacity 2.07 pounds per inch per 100 grains per square yard.

The softness and/or the flexural rigidity of this fabric is also determined by the two techniques outlined in Example 2. The Handle-O-Meter test evaluated the softness of this fabric at 91 while the trumpet test evaluated this fabric at 15 grams of force.

EXAMPLE 4

For comparative purposes comparable weight nonwoven fabrics were made from all staple-length fibers and the strength and softness of these fabrics determined in the same manner as outlined in Examples 2 and 3.

The first of these all staple-length fabrics was made from 4 carded webs each weighing approximately 70 grains per square yard and made from viscose rayon fibers $1\frac{1}{2}$-denier, $1\frac{9}{16}$ inches in length. Two of the webs formed the outer plies of a 4-ply laminate while the other two webs were angle-laid between these outer plies with one ply running at 60° measured clockwise from the length of the fabric and the other ply running at 60° measured counterclockwise from the length of the fabric. The 4-ply laminate was held together by a viscose binder applied in a pattern of 6 lines per inch with the lines running at 45° to the length of the fabric. The total weight of the fabric was 300 grains per square yard, 20 grains of this being binder and 280 grains of this being staple-length fiber. The machine and cross-tenacities of this fabric and the softness as determined by the Handle-O-Meter and the trumpet test were determined in the same manner as outlined in Examples 2 and 3 above and are given in the following table.

The second all staple-length fiber nonwoven fabric was made by laminating 4 plies of normal oriented card web made from viscose rayon fibers $1\frac{1}{2}$-denier, $1\frac{9}{16}$ inches in length, with each ply weighing approximately 80 grains per square yard and with all of the plies running in the same direction, i.e., the machine direction of the final fabric. The four plies were held together by a viscose binder applied in a pattern of 6 lines per inch with the lines running at 45° to the length of the fabric. The final weight of the fabric was 340 grains per square yard with 20 grains of this being binder and 320 grains per square yard being staple-length fiber.

Again, this fabric was tested for its machine tenacity and its cross-tenacity and its softness by both the Handle-O-Meter and the trumpet test as outlined in Examples 2 and 3. These results are also given in the following table.

	Fabric of all continuous filament webs Example 2	Fabric with outer plies staple length fiber webs and angle-laid inner plies of continuous filament webs Example 3	All staple length fiber fabric, inner plies angle-laid Example 4	All staple length fiber fabric, inner plies not angle-laid Example 4
Fabric weight (gr/yd²)	340	302	300	340
Weight Binder (gr/yd²)	20	20	20	20
Weight Continuous Filaments (gr/yd²)	320	112	—	—
Weight Staple Length fiber (gr/yd²)	—	170	280	320
Binder pattern (all viscose)	6-45° lines per inch	12-20° lines per inch	6-45° lines per inch	6-45° lines per inch
Machine direction tenacity (#/inch 100 gr/yd²)	2.15	1.21	.91	1.19
Cross direction tenacity (#/inch 100 gr/yd²)	1.66	2.07	.27	.11
Softness by Handle-O-Meter Test	86	91	74	73
Softness by Funnel Test	10	15	25	26

The four examples of the above table were of comparative weights. The amount of binder applied in each instance was the same and the manner in which the binder was applied was comparable in all cases. As can be seen from this table the fabrics containing the continuous filament webs were both considerably stronger and considerably softer than the fabrics made from all staple-length fibers.

WHAT WE CLAIM IS:—

1. A non-woven unitary web of individual synthetic textile filaments (as hereinbefore defined), of from 1 to 10 denier each having an irregular sinuosity through its length presenting looped fibre portions which overlap and frictionally engage looped fibre portions of adjacent filaments in the web, said individual filaments in a unit section of the web each having a length in its irregular

sinuous form substantially equal to the length of said unit section in the direction of filament lie and a length in its straightened condition substantially equal to the corresponding length of its associated filaments in their straightened condition, said web being of substantially uniform construction throughout and having substantially all of its filaments lying in the same general direction.

2. A non-woven unitary web according to Claim 1 in which the filaments are of from $1\frac{1}{2}$ to 6 denier.

3. A non-woven unitary web according to Claim 1 or 2 in which the filaments are cellulosic filaments.

4. A non-woven unitary web according to Claim 3 in which the filaments are viscose rayon filaments of from $1\frac{1}{2}$ to 3 denier.

5. A non-woven unitary web according to any one of Claims 1 to 4 weighing from 25 grains per square yard to 200 grains per square yard.

6. A non-woven unitary web of individual synthetic textile filaments (as hereinbefore defined) constructed and arranged substantially as hereinbefore described and shown in Figures 1, 2, 8, 9, 10 of the accompanying drawings.

7. A method of producing a non-woven unitary web of continuous synthetic filaments (as hereinbefore defined) which comprises presenting a tow of continuous synthetic filaments of from 1 to 10 denier to a liquid flowing through a chamber, conveying said tow in the liquid in the same direction that the liquid is moving, maintaining the tow under tension while in said liquid, and uniformly applying diverging hydraulic forces to said tow while under tension and being conveyed in said liquid whereby the tow is spread into a thin web of continuous filaments and is then picked up from the liquid at a slower speed than the speed of the tow while in said liquid.

8. A method according to Claim 7 in which the tow is conveyed in the liquid at a velocity slower than that of the liquid.

9. A method according to Claim 7 or 8 in which the thin web of continuous synthetic filaments is uniformly compacted in a lengthwise direction whereby the filaments assume irregular sinuous paths and present looped portions which overlap and entangle looped portions of adjacent filaments to form a unitary web.

10. A method according to Claim 7 or 8 in which the thin web of continuous synthetic filaments is presented to a surface moving away from the liquid and at a speed slower than the speed of the web in the liquid whereby a thin web of continuous synthetic filaments each having an irregular sinuosity is formed.

11. A method according to any one of Claims 7 to 10 including the step of drying said unitary web to remove the liquid therefrom.

12. A method according to any one of Claims 7 to 11 in which the liquid is water.

13. A method of producing a non-woven unitary web of continuous synthetic filaments (as hereinbefore defined) substantially as hereinbefore described with reference to Figures 6 and 7 of the accompanying drawings.

14. A non-woven fabric comprising a plurality of fibrous webs at least one of which is a non-woven unitary web of individual synthetic textile filaments as claimed in any one of claims 1 to 6 or whenever produced by a method according to any one of claims 7 to 13.

15. A non-woven fabric according to claim 14 in which there is present a bonding agent holding the webs together to form an integral fabric.

16. A non-woven fabric according to claim 14 or 15 in which at least one other of said fibrous webs is of staple length fibres.

17. A non-woven fabric according to claim 16 comprising two superposed fibrous webs, one of said webs being of staple length fibres and the other of said webs being the non-woven unitary web.

18. A non-woven fabric according to claim 16 comprising three superposed fibrous webs, the outer webs of the fabric being of staple length fibres and the inner web of said fabric being the non-woven unitary web.

19. A non-woven fabric according to claim 14 or 15 comprising a plurality of non-woven unitary webs plied so that their long directions lie at angles to each other.

20. A non-woven fabric constructed and arranged substantially as described in Example 2 or 3.

21. A non-woven fabric constructed and arranged substantially as hereinbefore described and shown in Figures 3 and 4, or Figure 5 of the accompanying drawing.

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1,159,601 COMPLETE SPECIFICATION

4 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

Fig.1.

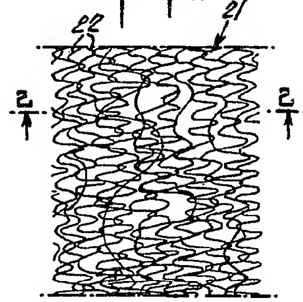


Fig.2.

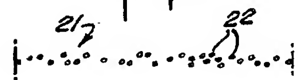


Fig.4.

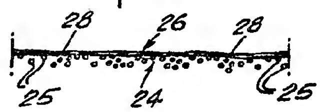


Fig.3.

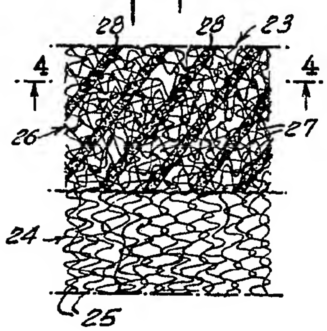


Fig.5.

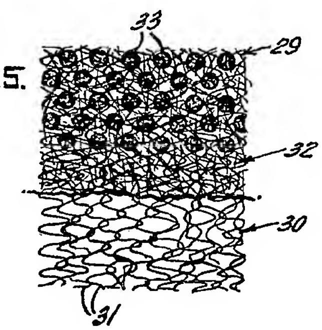


Fig.6.

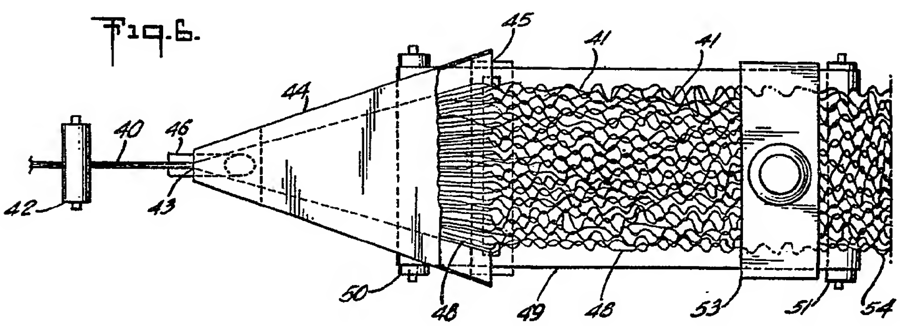
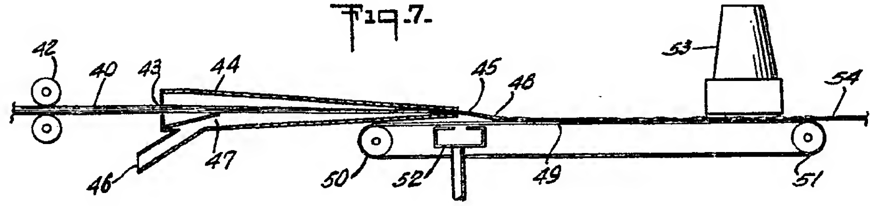


Fig.7.



1,159,601 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*
SHEET 2

Fig. 8.

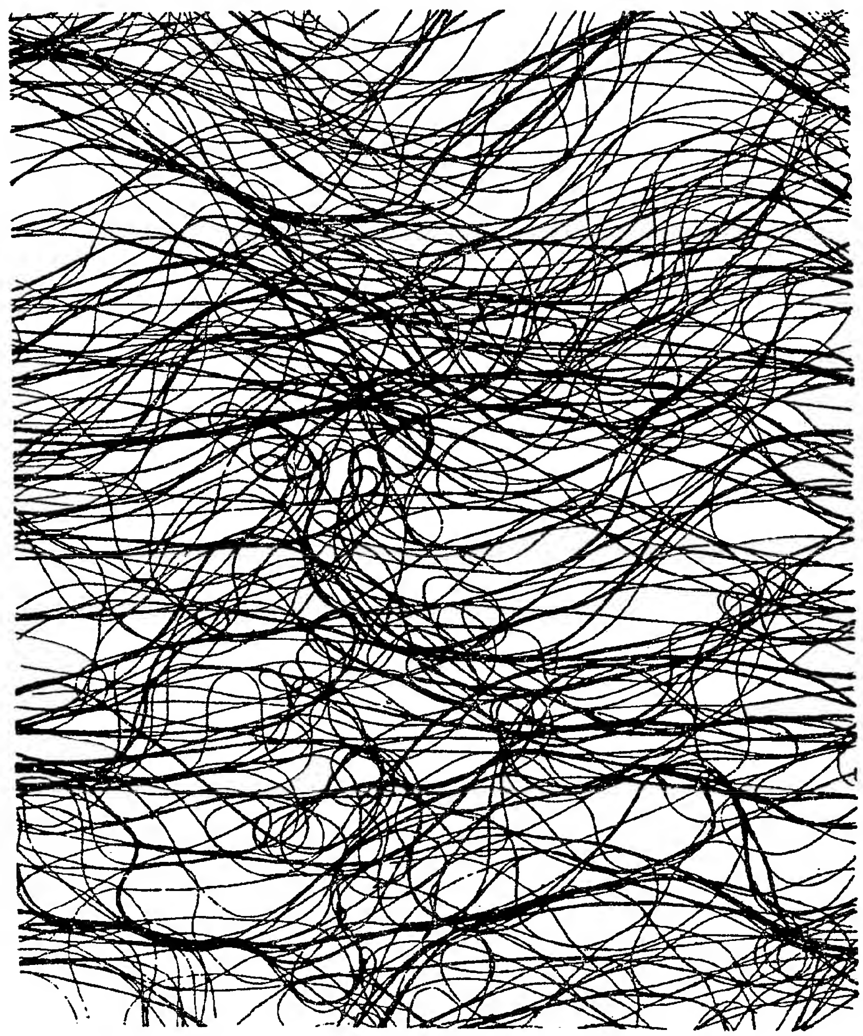


Fig. 9.

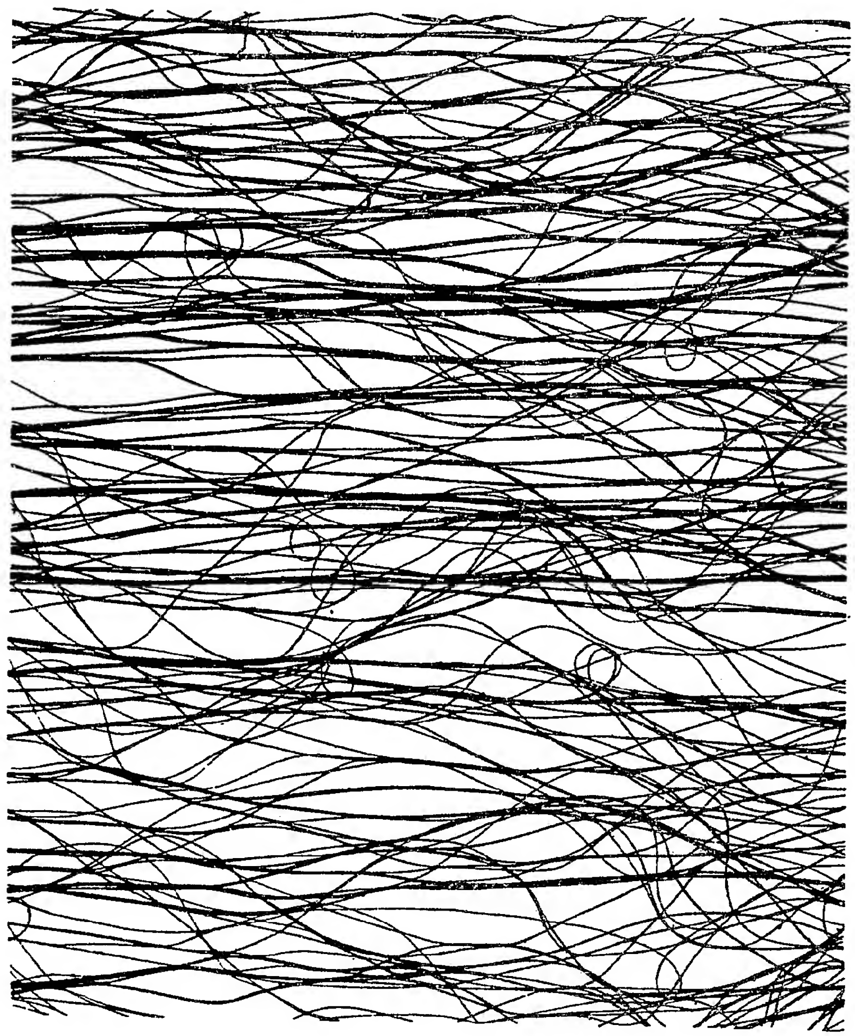


Fig.10.